SYNOPSIS

Removal of Heavy Metals From Waste Water Using Dry Biomass of Plants

पौधों की शुष्क जैव मात्रा द्वारा अपशिष्ट जल से भारी धातुओं का निष्कासन

Submitted To
MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER
For Ph.D. in Chemistry

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Appendix- IV-A

(Reference Ord. 124.11)

1. Name of Scholar(In English)	**Deepti Rangnani**
(In Hindi)	**दीप्ति रंगनानी**
2. Title of Research Work(In English)	**Removal of Heavy Metals From Waste Water Using Dry Biomass Of Plants**
(In Hindi)	पौधों की शुष्क जैव मात्रा द्वारा अपशिष्ट जल से भारी धातुओं का निष्कासन
3. Location	
a.) Institution/department where work is to be done.	**Department of Chemsitry, Government College,Ajmer**
b.) Geographical area of investigation, if any	**No**
4. Introduction,Importance of Proposed Investigation , Objectives	**Annexure – I(a) (b) (c)**
5. Review (work already done on the subject proposed Research Study)	**Annexure- II**
6. Research Gaps Identified in the Proposed Field of Investigation based on the review:	**Annexure- III**
7. Major Hypothesis, if any:	**Annexure- IV**
8. Research Methodology:	**Annexure- V**
9. List of referenced cited	**Annexure- VI**

Signature of the Candidate with date

Outline Approve

Name and Signature of supervisor with date & seal

Lecturer in Chemistry
Govt. College, AJMER

APPENDIX - IV

MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER

Certificate by Supervisor

Certified that:

1. I am willing to guide the research work of Mrs. Deepti Rangnani on the above subject if she is registered for Ph.D.

2. To the best of my knowledge, the subject selected has not studied and is not being studied so far in any University.

3. The subject is of sufficient scope to keep the candidate engaged for two years.

4. The subject will lead to a valuable contribution. I have seen and approved the outline of proposed research work submitted by the candidate.

5. I have 2 Research candidates registered under my supervision and the serial number of this candidate whose application is being forwarded for registration is 4 give the serial number).

6. The candidate is not in a close relation (the term of close relation is defined in the examination ordinance of the University).

Signature of the Supervisor with date
Lecturer in Chemistry
Govt. College, AJMER

Certified that the available facilities will be extended to Mrs. Deepti Rangnani for research work if she is registered for Ph.D.

Signature of the Principal of the institute with date
सम्राट पृथ्वीराज चौहान
राजकीय महाविद्यालय, अजमेर

Signature of the Head of the Dept. with date
Deptt. of Chemistry
Govt. College, AJMER

Annexure- I (a)

Introduction

Waste water contamination is ever increasing problem which the whole world is now facing. Waste water comprises liquid waste discharged by domestic residences, commercial properties, industries and agricultural units. Industrial waste constitutes the major source of metal pollution in natural water [1]. Toxic heavy metals (Cd, Zn, Pb, Ni, Cu, Cr, Mn etc.) are major pollutant of waste water which is very hazardous [2]. The release of these pollutants without proper treatment poses a significant threat to both environment and public health, as they are non-biodegradable and continual.

Therefore, it is necessary to treat metal-contaminated wastewater prior to its discharge to the environment. Adsorption is one of the promising processes for the removal of heavy metals from waste water. Adsorption is suitable even when the metal ions are present in concentration as low as 1mg/l .The adsorbents may be of mineral, organic or biological origin, zeolites, industrial by-products, agricultural wastes, biomass, and polymeric materials.

In the proposed research work Dry Biomass of following plants are used as adsorbents to study the process of biosorption.

1. Cassia fistula (Amaltas) (Family- Fabaceae)
2. Bauhinia variegate (kachnar) (Family – Fabaceae)
3. Syzygium cumini (Jamun) (Family- Myrtaceae)
4. Lantana camara (lantana) (Family- Verbenaceae)

All the above referred plants are rich in tannin content. . The polyhydroxy polyphenol groups of tannin are thought the active species in the adsorption process.

Annexure – I(b)

Importance of Proposed Investigation

Heavy metal pollution in aquatic system has become a serious threat today and of great environmental concern as they are non- biodegradable and thus persistent. Pollution by heavy metal ions such as Cu, Zn, Pb, Cd, Cr, Co, Mn etc. has become a major issue throughout many countries due to their possible toxic effects. These heavy metals are released into the aqueous environment through variety of sources such as metal smelters, textile industries, microelectronics industries and wood preservatives producing industries. It is also due to excess use of fertilizers and pesticides [3].

Heavy metals even at low concentrations can cause toxicity to humans and other forms of life, their adverse effects on human health are quite evident. The toxicity of metal ion is owing to its ability to bind with protein molecules and prevent replication of DNA and thus the subsequent cell division [4].To avoid health hazards it is essential to remove these toxic heavy metals from waste water before its disposal.

The treatments methods for metal bearing effluents commonly include reverse osmosis, electro dialysis, ultra filtration, ion exchange, chemical precipitation, etc. However all these methods have disadvantages like incomplete metal removal, high reagent and energy requirements, generation of toxic sludge or other waste product that require careful disposal [5].

Several studies are available on the use of adsorbents for removal of metal ions from effluents [6-11]. Commercial activated carbon (CAC) is widely used for absorbing various substances from industrial wastewater [12,13]. In this case, their use is usually limited due to their high cost. This problem has led to search for cheaper adsorption substitutes including fly-ash, lignin, natural materials (chitosan, alginate, biomass, etc.) and clays (clinoptilolite, montmorillonite) [14,15] etc.

Annexure- I (c)

Objectives

The main objectives of the proposed study are to investigate new low-cost adsorbent especially natural product to remove heavy metals from aqueous solution.

1. The following plants will be used as precursor for the preparation of the activated carbon charcoal:
   Cassia fistula (Amaltas) (Family- Fabaceae)
   Bauhinia variegate (kachnar) (Family – Fabaceae)
   Syzygium cumini (Jamun) (Family- Myrtaceae)
   Lantana camara (lantana) (Family- Verbenaceae

2. To evaluate the adsorption capacity of adsorbents different stock solutions will be prepared of heavy metals like as Cu, Zn, Pb, Cd, Cr, Co, Mn etc.

3. The metal concentrating in the sample will be determined using Atomic Adsorption Spectrophotometer (AAS).

4. The surface morphology of adsorbents will be analyzed by Scanning Electron Microscope (SEM).

5. In order to estimate the adsorption capacity (Qm) two isotherms will be tested namely Langmuir and Fruendlich isotherm.

Annexure – II

Review (work already done on the subject of proposed Research Study)

The survey of literature reveals that a wide range of low-cost adsorbents has been studied worldwide for heavy metal removal. Various researches on chitosan have been done in recent years. In 1988, the utilization of chitosan for cadmium removal was intensively investigated[16]. Natural zeolotes gained a significant interest among scientists due to their ion-exchange capability of preferentially remove unwanted heavy metals such as strontium and cesium [17].

Montmorillonite, which is a type of clay, has the highest cation exchange capacity and that its current market is considered to be 20 times cheaper than that of activated carbon [18].

Later on, the use of peat to remove heavy metals was investigated. It was observed that peat moss plays an important role in treatment of metal-bearing industrial effluents such as Cu, Cd, Zn and Ni [19]. Similarly, the study on the use of polyurethane foam as adsorbent has been discussed [20,21].

Phosphate treated saw dust showed remarkable increase in sorption capacity of Cr (VI) as compared to untreated sawdust [22]. Mangifera indica (Mango) seed and seed shell powders were studied for their possible application in the removal of Cu (II) from wastewater [23] The fruit peel of orange (Citrus reticulate) is a low cost adsorbent, which is abundantly available in India as waste material. The ability of fruit peels of orange to remove Zn(II), Ni(II), Cu(II), and Pb(II) and studied. [24]

Wide variety of agricultural wastes studies as adsorbent for decontaminating industrial/domestic wastewaters from toxic metals, include walnut waste, apple waste, maize cobs, peanut shell, cassava waste, jackfruit peels, fluted pumpkin waste, olive pomace, wheat bran, coconut shell, coir pith, rice husk, bagasse,[25-28] etc. In 2005, the usage of tea waste like the most other natural adsorbent was used in treatment process of heavy metals. The cell wall of waste tea consist of cellulose, lignin, carbohydrate which have hydroxyl group in their structure and could be good adsorbent for contamination [39-40].

Annexure- III

Research Gaps Identified in the Proposed Field of Investigation based on the review

1. Survey of literature reveals that low-cost adsorbents have demonstrated outstanding removal capabilities for certain metal ions as compared to activated carbon.
2. Similarly, studies on low-cost adsorbents such as chitosan, zeolites, waste slurry, lignin etc. are present in the literature. However, systematic study on natural products as low-cost adsorbent is still in infancy.
3. Although many research works have been done recently to find the potential of using various alternatives adsorbents, so far no efforts have been made to obtain a comparative overview of adsorbents in terms of their removal performance, adsorption capacity, and cost effectiveness.

Annexure- IV

Major Hypothesis, if any:

Waste streams containing heavy metals which are non biodegradable and tend to accumulate in living organism causing various disease and disorders. For heavy metal removal, activated carbon has undoubtedly been the most popular and widely used adsorbent in wastewater treatment throughout the world. In spite of its prolific use, activated carbon remains as expensive material. It also requires complexing agents to improve its removal performance for inorganic matters. Due to these problems research interest into the production of alternative adsorbents to replace the costly activated carbon has intensified in recent years.

So in this research work it is expected that new low-cost adsorbents will be investigated, which have metal binding capacities and will be able to remove unwanted heavy metals from contaminated water. Adsorbents that stand out for high removal efficiencies and adsorption capacities will be compared with the activated carbon.

Annexure- V

Research Methodology

1. **Preparation of Adsorbent:**
   A) The sample will be washed by distilled water to remove particulate materials from its surface.
   B) It will be dried at 60^{o}C for 72hrs. and grinded into sizes range of 0.5-1.0mm.
   C) The dry sample will be carbonized and soaked in NaOH.
   D) The acticated product will be treated with HCl for the removal of impregnating salts.

2. **Preparation of Stock solution:**
   The stock solutions will be prepared by dissolving heavy metals such as (Zn, Cd, Cu, Pb, Cr, Co, Mn etc,) in nitric acid prior to dilution with deionized water.

3. **Adsorption study:**

   a) Effect of Adsorbent dosage:
   1. Different dosages of adsorbent will be added to working standards.
   2. These samples will be placed on a rotatory shaker at 150 rpm.
   3. The concentration of the residual heavy metal solution will be determined by using AAS.

   b) Effect of Adsorbent initial concentration:
   Different percentage concentration solutions will be prepared and fix amount of adsorbent will be added to the solution.
   Concentrations of residual heavy metal solution will be determined by using AAS.

   4. Adsorption Isotherm Models:
   In order to estimate the adsorption capacity (Qm) two isotherms will be tested namely Langmuir and Fruendlich isotherm.

The Langmuir isotherm can be written in linear form as:

$$\frac{C_e}{q_e} = \frac{C_e}{Q_m} + \frac{1}{Q_m b}$$

Where , q_e and C_e are the metal equilibrium concentration is absorbed and liquid phase in mmol/g and mmol/L, respectively. Q_m and b are the Langmuir constants representing the sorption capacity (in mg/g) and energy of sorption, respectively. These constants can be calculated from the intercept and the slope of the linear plot, C_e / q_e Vs C_e.

The Fruendlich isotherm equation can be written in the linear form as:

$$\textbf{Log } q_e = \textbf{log } K_f + 1/n \textbf{ log } C_e$$

Where K_f and n are indicators of sorption capacity (in mg/g) and intensity respectively. These fruendlich constants can be calculated from the slope and intercept of the linear plot with **log q_e Vs log C_e**.

Annexure- VI

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